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graceful and striking shapes, they were not the somber bodies we find them to be in the rocks, but formed the most delicately woven fabrics of glass, latticed vases, urns and cups of the rarest delicacy and beauty. They must have been, when denuded of their sarcode, among the most exquisite structures of the past, as their descendants are of the present. Nothing, for example, could have surpassed the graceful filigreed chalice of *Botryodictya ramosa*, with its slender, tufted pedicel expanding above with a cup ornamented with pendant pouches."

In the list of genera and species, twenty-eight genera and one hundred and twenty eight species of these organisms are recognized, a great majority of them being here described for the first time. These descriptions of genera and species, with the introductory portion of the volume, fill two hundred quarto pages of text, and they are illustrated by seventy finely executed lithographic plates.

S. W.

Geological Report on Isle Royale, Michigan. By ALFRED C. LANE.

Geological Survey of Michigan, Vol. VI, Part I. Lansing, 1898, pp. i + 281. 16 plates, 29 figures, 13 tables.

The report begins with a historical sketch of the mining operations from pre-historic times to the present. This is followed by a description of the method of constructing cross sections of the country from drill records, and this by an account of the succession of rocks forming the island, involving a detailed statement of the rocks traversed by sixteen drill holes. The results are compared with Irving's cross sections of Keweenaw Point, and the conclusion reached that there is represented on the Isle Royale practically the whole of the copper range as it exists from the Central mine to Portage Lake. A comparison is made with the Minnesota section with less definite results.

The portion of the report of more general interest is that which treats of the grain of rocks, both the theoretical discussion and the application of the theory to the rocks under investigation. The discussion opens with the consideration of conditions that affect cooling of molten magmas. Laws controlling the loss of heat are expressed mathematically, and diagrams are constructed exhibiting rates of cooling under various conditions. Deductions regarding the variations

in the grain of rocks corresponding to these conditions are exceedingly important and interesting. Some of the theoretical deductions are as follows : (1) After the temperature at the center of an intruded magma has fallen about one fourth of the interval between the initial temperature and the marginal temperature, the rate of cooling at a given temperature is the same for all parts of the sheet. (2) If the initial temperature (of intrusion) and conditions of cooling are such that a considerable time elapses before any part of the sheet reaches the point of solidification, the rate of cooling will be the same at all points, and, so far as the grain is dependent on it, there will be no change of grain, but the grain will be uniform from margin to center. (3) The hotter the dike or sheet initially, the less will be the width of the marginal zones of gradually finer grain ; also, the hotter the country rock, the less pronounced will be the marginal zone of finer grain. (4) The time of cooling varies as the square of the thickness of the dike or sheet, so that a dike 200 feet thick will cool four times as slowly, other things being equal, as a dike 100 feet thick. (5) Before the center (of an intruded mass) begins to cool off, the time required for a given loss of temperature for any point will vary as the square of its distance from the margin.

In applying the theory to the rocks examined it was found that some minerals, such as augite and feldspar, conformed fairly with theoretical requirements. In the case of sheets which have solidified before the center had appreciably cooled, it was found that "the area of cross sections or surface of the grains varies directly as the slowness of cooling." Again, "the linear dimensions of the augite patches (in the ophites, are directly as the distance from the margin."

With regard to the effect of chemical composition on grain, it is announced that "other things being equal, the greater the abundance of its constituent molecules, the coarser the grain of any mineral."

In conclusion, Dr. Lane ventures the prophecy "that it will prove widely true that superficial (extrusive) basic rocks are characterized by an increase of grain to near the center, while deep-seated basic rocks have a broad central zone of nearly uniform grain." He remarks in connection with the question of the effect of geological environment upon rocks that "it must also be remembered that the possession and loss of gas by diffusion follow the same laws as the possession and loss of the imponderable 'caloric,' while the possession of gas may greatly lower the temperature of solidification as glass."

The report closes with chapters on the petrography of the rocks; on the topography and Quaternary geology; the stratigraphy; and the chemical problems which are treated briefly. The last chapter is devoted to diabases, probably Keweenawan, intrusive in the Huronian. Among various interesting observations made in connection with these rocks is the conclusion that the micropegmatitic (micographic) intergrowth of quartz and feldspar found in some of them is undoubtedly a primary crystallization, and not a result of alteration in the rock.

J. P. I.

The Department of Geology and Natural Resources of Indiana.
Twenty-third Annual Report. By GEORGE H. ASHLEY,
Ph.D., Assistant State Geologist.

The report consists of 1741 pages, the first 1573 of which are devoted to the coals and coal area of the state. The state geologist, Mr. W. S. Blatchley, is to be congratulated on having secured, for this work of such importance to the state, the services of so painstaking and energetic a worker as Dr. Ashley.

The primary idea of the author seems to have been to make the report of the greatest possible value to those interested in the coal industry. Nevertheless it discloses much that is new concerning the structure of the southwestern part of the state, and throws light on the physical conditions that attended the formation of the Coal Measures of the eastern interior coal field.

Instead of using the letters of the alphabet to designate the different coal beds, as is done by Mr. Cox in the Seventh Annual Report, or Arabic numerals, as was done in the Illinois and Kentucky reports, the author has made use of Roman numerals, each of which denotes a division of the Coal Measures. There are eight of these divisions, numbered from below upward. In those localities, where a division includes more than one coal bed, the small letters of the alphabet are brought into use. For example, the three coals of Division v are designated v, va, vb. This method seems to present the advantage of at all times denoting the exact horizon under consideration, and of locating the beds of small area.

The organization of the volume divides it into four parts. Part I dealing with the Geology of Coal; Part II, with the General Geology